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National Field Research Center, Inc, Iowa City, IA

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ENVIRONMENTAL/ENERGY
WORKFORCE ASSESSMENT
PHASE III

PROBLEMS IN ENVIRONMENTAL EDUCATION & TRAINING

1979

Conducted by:
NATIONAL FIELD RESEARCH CENTER, INC.

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16. ABSTRACT

This report is one of 18 volumes in Phase III of the National Environmental/Energy Workforce Assessment. Based on information from Phases I and II of the Assessment, the report describes representative problems in environmental education and outlines solutions recommended by the post-secondary environmental education and training sectors. Noting that there is an adversary relationship among the groups responsible for environmental education and training, the report recommends that the Environmental Protection Agency take the role of catalyst by sponsoring working dialogue sessions of small groups of persons actively involved in environmental education and training.

In addition, Phase III includes 12 volumes (directories) on post-secondary environmental education programs. The other five volumes in Phase III are as follows: Salaries and Attendant Problems of Public Sector Environmental Employment; The Role of CETA in Direct Training and Employment; Private Sector Training Activities; Environmental Employment in Public Service Jobs Programs; and a Workforce Planning Bibliography.

Phase I of the Assessment evaluated workforce needs for pollution control and abatement in the U.S. during 1976-81. Phase II gathered data on training and educational programs in the post-secondary environmental education field as of 1978.

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INTRODUCTORY NOTE

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A special word of appreciation is extended to Mr. J. Donald Cook, Chief, Workforce Coordination Team, U.S. Environmental Protection Agency, Washington, D.C., and to the Manpower Officers and Workforce Coordinators from each of the U.S. Environmental Protection Agency Regional Offices.

PROJECT BACKGROUND

Overview

The National Environmental/Energy Workforce Assessment is a three-phase project to explore environmental and energy training, education, and employment in depth. The project, conducted by National Field Research Center, Inc., under the direction of the U. S. Environmental Protection Agency, is a direct response to a 1975 Congressional call for an inquiry into the availability and readiness of our national workforce for increased pollution control and abatement efforts.

In keeping with the objectives of the inquiry, this nation-wide study has been directed toward the assessment of environmental/energy workforce status and needs, national educational emphases and status, and the functional interface of the two.

PHASE I

Phase I focused upon the development of "workforce demand projections" through 1982 for all public environmental agencies. The on-site assessment culminated in a numerical profile of the growth patterns and workforce needs at the national and state levels. Stratification of the overall defini-

tion of "environmental occupation" into seven distinct vocational areas enhanced even further the applicability of the results. In addition to this public sector workforce assessment, Phase I included an overview analysis of private sector needs (conducted through an adjunct mail survey of selected businesses and industries) and a brief review of selected environmental educational programs.

Phase I was completed in May, 1977. The 70 volume final report included:

National Abstract	(1)
National Legislation	(1)
Regional Assessments	(10)
State Assessments (including District of Columbia, Virgin Islands, and Puerto Rico)	(53)
Business and Industry Assessment	(1)
National Summary	(4)

PHASE II

The Phase II objective was to determine the "state of the art" of the educational community in generating a qualified and employable environmental workforce. Community colleges, vocational-technical training institutes, colleges and universities,

and environmental training centers throughout the nation were visited; thousands of catalogs were reviewed.

The result was a profile of environmentally related post-secondary educational programs. Aspects subject to careful review included: program structure, representative course offerings, enrollment projections, program completion requirements, faculty composition, and employment history of program graduates. Program offerings were summarized and common issues and problems were discussed.

The Phase II report included 13 volumes arranged as to medium under consideration, namely:

Air	
Energy	
Noise	
Pesticides	
Potable Water	(2)
Radiation	
Solid Waste	
Wastewater	(2)
Composite	(3)

These volumes were augmented by a summary volume, an abstract, and a special volume, Business and Industry/Trade and Professional Associations.

The latter includes the results of a survey of a variety of businesses, industries, and trade and professional associations as to their efforts in training programs related to pollution control and abatement, environmental research, and resource conservation.

PHASE III

Under Phase III, materials from Phases I and II were analyzed and synthesized. Issues which were revealed to be of special importance to the future of our environmental/energy workforce, in terms of availability and quality, are being highlighted in a series of monographs, of which this is one.

The monographs focus upon salient aspects of the NE/EWA findings in greater detail than possible in the formats of the previous phases. The four monograph titles are:

- *Salaries and Attendant Problems of Public Sector Environmental Employment*
- *The Role of CETA in Direct Training and Employment*
- *Private Sector Training Activities*
- *Problems in Environmental Edu- and Training*

In addition to the four monographs, a report of the issues related to the use of Title VI CETA in carrying out environmental pollution control and abatement activities was developed. A search of the Title VI records on file with the U.S. Department of Labor, coupled with interviews with representatives of numerous prime sponsors provided the basis for the observations contained in that report.

A third objective was to develop, by medium, a listing of all post-secondary institutions offering environmental programs. All catalogs reviewed during Phases I and II were re-examined and replaced with updated versions when warranted. This information was compiled into a listing of schools offering environmental programs of study and organized as to program area. Finally, Phase III researchers developed an annotated bibliography of material of potential value to environmental workforce planners.

INTRODUCTION

The NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT PROJECT, conducted for the U.S. Environmental Protection Agency by the National Field Research Center, Inc., is a national effort directed at environmental/energy workforce requirements, national environmental education preparedness, and the functional relationship between the two. The project has been developed as a multi-phase, multi-faceted inquiry into the state of preparedness of our environmental workforce. In an attempt to extract and to coordinate the information from Phase I and Phase II, this monograph endeavors to present, in an integrated fashion, some of the representative problems and recommendations from the environmental post-secondary education/training sectors. While universities, colleges, training institutions, and public and private sector agencies and industry are at least overviewed, the current role and responsibility of the U.S. Environmental Protection Agency is also addressed herein.

In October of 1977, a three-year UNESCO International Environmental Education Program culminated in the ministerial level Intergovernmental Conference on Environmental Education at Tbilisi, U.S.S.R. Participants included 66 official governmental delegations of UNESCO member states and observers from eight other United Nations organizations and twenty international non-governmental organizations.

The conference purpose was: "...to formulate recommendations for action which might be undertaken at the national, regional, and international levels for the promotion and development of environmental education." [1]

One concept pervades the literature reporting the deliberations and outcomes of the conference: Integration. Integration was the guiding principle of the conference and the underpinning of the goals and recommendations for action which followed.

Integration is an easily understood, often discussed concept—in theory. We lose it in the shuffle of implementation. There are few geniuses among us. We must deal with problems one step at a time; we must compartmentalize and simplify in order to comprehend and act on matters before us. Thus, we speak of environmental education and

environmental training, even though we may not be able to determine an absolute dividing line. We separate public and private sector, then divide the latter into business and industry and subdivide those by relative size. The former is broken down into federal, state and local. Pollution control and abatement problems and efforts are separated into exclusive media areas. Post-secondary education is categorized by type of institution.

All of this reduction and simplification provides us with entities of smaller dimensions which are easier to grasp mentally. But, there are side effects. Artificial lines of demarcation tend to become perceived as solid, absolute boundaries. As we focus on any one entity, its significance increases to fill the screen as other aspects, which we have designated as peripheral, recede.

This monograph discusses several problem areas plaguing environmental education and training and does so from a variety of perspectives. To an individual interested in a single area to the extent that the significance of the "peripheral" has been lost, much of the content may seem irrelevant. It is hoped that the reader will be disposed to an effort at broadening horizons; that, even though the monograph is divided into typically relatively free-

standing sections, it will be read in its entirety. Through a renewed understanding of the complexities of the spectrum of environmental education and training and a consequent greater appreciation of the nuances of the problems as they affect other professionals, potential solutions may become apparent. Every "externality" that is redefined as an essential element of the problem becomes a piece which contributes to a practical, realistic solution.

ENVIRONMENTAL WORKFORCE EDUCATION AND TRAINING:

NEEDS AND STRATEGIES

Mark Twain's observation upon the topic of weather (Everyone talks about it; no one does anything about it) can be applied without loss of meaning or wry humor to the topic of environmental education/training. It has been the subject of many a conference at the state, regional, national, and even international level. Conference programs have boasted illustrious participants, great debates ensued, and magnificent reports were drawn up and published. Still, few people honestly can affirm that the efforts have resulted in solving more problems than they have created, or even that people have gone away with a better appreciation of what others are doing and why.

Long-time residents of several parts of the nation enjoy replying to visitors or newcomers who have complained about the local weather, "Wait three days (or hours); it'll change." That statement, too, applies to environmental education and training. It is important to note that although change was promised, there was no guarantee that the change would be to the complainer's liking.

With weather, the complaints center on: too hot/too cold, and too wet/too dry. With environmental education and training, it's: too/much too little, too many/too few, and too general/too specialized. There are erudite proponents for each side of the issues, all with sound justification for their arguments. Perhaps, unlike the weather, something could be done if participants in the great debate would give opposing views the same attention and full consideration accorded those with whom they agree.

Agency Perspectives

During the NATIONAL ENVIRONMENTAL/ ENERGY WORKFORCE ASSESSMENT PROJECT, Phase I and II, researchers recorded many comments from federal, state and local personnel regarding education and/or training. The following are representative state samplings of these comments: [2]

> "Engineering personnel with a basic bachelor degree education do not possess sufficient knowledge of wastewater pollution control and abatement techniques upon graduation." (Alabama Water Improvement Commission)

"The training programs which are available through state universities, community colleges, and technical schools, are not considered to offer the requisite degree of technical information. Noticeable discrepancies between training and on-the-job activities exist. Input from potential employers is needed in curriculum development." (California Air Resources Board)

"Entrants lack requisite knowledge and skills. There are disparities in graduate curriculum and current job demands. (Connecticut Department of Environmental Protection, Water Compliance and Hazardous Substances)

"Universities need to receive input from state program personnel in the planning of courses and programs. Drastic changes are not needed, but slight modifications to meet state requirements, e.g., engineering programs need to include courses in data management." (Florida Department of Environmental Regulation, Bureau of Drinking Water)

"State agencies should have input into planning of educational programs. Most professors have had no practical experience. Training programs should be developed for samplers and enforcers." (Florida Department of Environmental Regulation, Air Quality Management Bureau)

"There is an increasing need for courses in solid waste management in undergraduate and graduate environmental curricula. In the future there will be more need for specified solid waste curricula, especially at the undergraduate level." (Florida Department of Environmental Regulation, Solid Waste Management)

"There is a need for programs in noise (or at least courses) at all levels. Local programs need persons from two-four year programs, and state agencies need persons with bachelors or master's degrees. (Florida Department of Environmental Regulation, Noise Section)

"Technician training (especially in community college programs) is well thought of, although often too specific in content. Division people feel they would rather depend upon on-the-job training to round out the competencies of technician level personnel than to have community college training broadened. Conversely, education of professional level personnel is often thought to be too broad and not specific enough to air pollution problems. On-the-job experience is considered the best remedy." (Illinois Environmental Protection Agency, Division of Air Pollution Control)

"The training programs currently offered through state colleges and universities and technical schools do not offer the degree of technical information required. There is a discrepancy between curricula and on-the-job activities. Professors sometimes are not up-to-date on the requirements of the field." (Kansas Department of Health and Environment, Bureau of Air Quality)

"There is a lack of basic coursework in engineering curricula; they have been watered down in the last five years. They are leaving out vital courses such as structures, fluid mechanics, etc. The schools are letting down educational standards to produce more engineers. As a result, many graduates are not nearly qualified to become licensed Professional Engineers." (Kentucky Department for Natural Resources and Environmental Protection Water Quality)

"Universities are offering environmental education curricula that are too academic and not practical in orientation." (Kentucky Department for Natural Resources and Environmental Protection, Division of Air Pollution)

"Schools need to emphasize 'practical applications' by use of internships and co-operative work arrangements." (Mississippi Department of Agriculture & Commerce, Division of Plant Industry)

"There is a need for increased health physics curricula." (Mississippi State Board of Health, Division Radiological Health; and, South Carolina Department of Health and Environmental Control, Bureau of Radiological Health)

At the Federal level, U.S. EPA Region IV made the following observations regarding education and training.

"Engineering programs have a lot of variation on how adequate they are in preparing people for work. The best teach students to organize and analyze problems." (Wastewater personnel)

"Not enough programs are available for training engineers to enter potable water programs. What is needed are engineers with background in public health." (Potable Water personnel)

"Many schools offer curricula which train generalists. What is needed is a generalized curriculum with an area of specialization.

> There should be courses offered in hazardous wastes, but they are now practically non-existent." (Solid Waste personnel)
>
> "Colleges and universities are not adequately training engineers in the field of air pollution control, and it takes a new entrant at least one year to become fully competent in the job. A reason is that most professors are not fully attuned to what is happening in the field. They need to maintain a closer liaison with what's really going on, and teach more application." (Air Pollution personnel)
>
> "Engineering programs are too general, and don't give students a grasp of real engineering. More practical work is needed, and students need to learn calculations, and to be able to put concepts in numerical terms. Colleges need to be more specific in environmental course work." (Water Surveillance and Analysis)

Obviously, the general complaint is that universities are not training students adequately in order for them to perform the designated job functions in an effective manner. Most employers, upon hiring new personnel, argue that the extensive on-the-job training, which is required for new employees to be able to function efficiently in

their positions, should have taken place during the educational process. The demand for specialists in air and water pollution abatement processes as well as solid waste, noise and radiation is growing continually. University training, apparently, is not meeting that demand from the viewpoint of employers whose concern is finding an individual to fill a specific position with specifically delineated functions and responsibilities.

For the most part, public agencies are challenged by the task of refining the general educational background of a new employee. It is expensive; it is time consuming; it is often a waste of effort. Due to the higher wage schedules in the private industry job market, public agencies suffer from a high turnover rate. Very often graduates will find entry level positions in public agencies, receive very specialized on-the-job training and then migrate into the private industrial workforce for higher salary opportunities. As a result of this unbalanced state of affairs, public agencies, in particular, are hard-hit by the lack of specialized education available for environmental workforce positions and are continually in the process of training and retraining personnel.

Academic Perspectives

In recent years many universities have initiated environmental programs in an attempt to fill the demands of the environmental workforce. While these programs are relatively new and much has yet to be learned about areas of curriculum concentration, the basic fear of educators and students alike is that of over specialization. Especially in this decade of runaway inflation and imminent recession, the prospect of finding employment with a very narrow field of educational background is limited. Although the demand for specialists is ever increasing, there are still only so many job openings for any one specialty and when they are filled the remaining "specialists" will have a very dim employment outlook. The nightmarish plight of thousands of highly skilled very specialized aerospace engineers did not go unnoticed. For this reason most educators and students are aiming at broader educational backgrounds which will provide greater opportunities for employment. As a result of this over specialization fear, graduates are not being prepared for specific job duties. Extensive on-the-job training must be provided to prepare graduates for a particular job.

The comments and criticisms of agency personnel were shared with educators during Phase II of NE/EWA. The following are representative of responses: [3]

"We start with an 18 year-old high school graduate. We have 120 to 130 classroom course credit hours to provide a bachelor's level education. The first two years are spent exposing him to the general knowledge accumulated over the past 2,500 years and in teaching him to think, to react to that knowledge and to communicate that reaction. The next two years are spent preparing the student in a relatively specialized area intended to qualify him for entrance into a career track which may last a lifetime. To narrow that preparation to fit precisely into the requirements of any one entry level job description is unrealistic."

"Much of the success of our generalist-oriented masters program is the result of students who come back to school saying that their job requires a knowledge base and set of skills beyond their more technical bachelor's preparation. They point out that their job description is incomplete–that it is specific as to the technical aspects, but it doesn't include the types of things that take up a large part of their job activity."

"It's true, we don't keep as current in the newest developments as would be desirable. I teach three courses a semester; I can't keep on the cutting edge of each area and work closely with my students as individuals at the same time. The best we can hope to do is provide the basics and encourage the student to explore further. Our internship program was started for just this reason. It's a feedback situation. I've learned a lot from returning intern students. Things they have picked up in their on-the-job experience have been included in my classroom presentations."

"We agree with the need for the practical, hands-on approach. Internships are the ideal solution, with a solid generalized base. A large portion of our job placements are a direct result of the internship experience. It gives us an advantage over programs without internships. We're working toward more formalized, expanded internship agreements with state agencies and industries in the state."

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and not have the slightest idea why those functions are important or how they fit into the larger scheme of things. That kind of approach works well in the military where a private is not expected to become a colonel; but for the rest of the world, the guy who starts at the bottom may be running the operation in twenty years. He's got to understand the whole system."

Despite the overwhelming demand for highly specialized personnel, we must not overlook the drawbacks of specialization. As knowledge advances, mastery of any particular subject leads to continually narrower specialization. All principal disciplines have broken into innumerable subdisciplines. Economics, for example has branched into labor, economics, agricultural economics, transportation economics, and at least a half-dozen others. Within the fields of law, medicine and engineering, specialization and fragmentation have evolved to comparable if not greater levels.

The central problem associated with specialization is that the important problems facing humanity do not fit within the confines of any individual discipline, much less a subdiscipline. Thus, in what educators have called the "expert society," more

and more problems remain unsolved, and many more are proving unmanageable.[4] Melvin Eggers, President of Syracuse University, has said that education is losing touch with the needs of society. When confronting the energy crisis, he notes, "We have petroleum and mining and nuclear engineers, but precious few energy engineers," who are capable of evaluating and advising on the overall energy situation.[5] On the world scale, not surprisingly, few governments have developed workable strategies for coping with this major threat to their national economic well-being and stability. Similarly, in the not too distant past, the food problem was defined almost entirely in agricultural terms. But to even begin to understand the trends in the present world food economy, an analyst must be an economist, ecologist, agronomist, meteorologist, demographer and political scientist all rolled into one,[6] or more feasibly, have the valuable input of all available and, ideally, have their efforts coordinated by an individual prepared with a background of broad, integrative perspective.

At the present, individuals with broad educational backgrounds containing little or no specialization are finding the employment outlook to be nearly as grim as for those who are overspecialized.

Employers tend to shy away from hiring anyone who does not have a clearly defined set of skills or abilities. Usually the job of synthesis is left for either the administrators, who often have very highly specialized backgrounds and tend to see problem-solutions in the light of their own specialities, or the specialists themselves, who have very difficult times recognizing that any aspects beyond their own narrowly based expertise have any bearing on the problems.

The need for the generalist has for the most part been overlooked by environmental workforce employers. Despite all the efforts of the environmental movement, employers still do not realize the value and the desperate need for environmental problem solving management. In order to utilize the technical advancements discovered by the specialists to their fullest potential, decisions must be made with understanding of the effects of economics, political science, sociology, humanities and other areas of scientific advancement. Only the generalist with broad educational experiences in all of these fields can hope to synthesize even a fair portion of the interrelated factors which affect the results of progressive environmental action. A great deal of duplication of effort could be avoided with proper

planning and management techniques. Multi-disciplinary educated personnel for management and planning must be given a chance in the workforce world if truly cost-effective solutions are to be implemented in future programs.

The lack of demand for the environmental generalist is primarly caused by the extent to which many interrelated fields have been departmentalized and the resultant lack of communication between the fields. A primary example of this is the way in which responsibilities have been allocated among government agencies. More often than not, work efforts are duplicated, sometimes many times over, due to poor inter-agency communications.

The EPA is beginning to bridge a few of these gaps but a great deal more progress must be made to coordinate the efforts of the different agencies in order to make the best utilization of workforce production. This is where environmental generalists need to be implemented. Coordination plays a vital role in the process of human environmental problem-solving. Another dramatic example of this need can be found when we look at the progress in one field, say air or water pollution abatement, as it compounds problems in other fields, i.e., solid and hazardous wastes.

The future of environmental education and, for that matter, the entire environmental workforce most probably lies in the team approach. The concept of a renaissance environmental man is not realistic with the complexity of environmental problems.[7] No one person can possibly amass enough knowledge about enough subjects to meet the need of ordering man-environmental relations for long-term harmony. Environmental education will be strong to the extent that it incorporates specialization into the paths led by the generalists.[8] All too often specialists come in conflect because there is a lack of knowledge on the process of integration. Specialization is a natural, necessary and essential response to the growing complexity of man-environment related problems. But generalists are needed to balance, synthesize, and integrate the work of specialists, bringing it to bear on public policy.[9]

There is a need for both the specialist and the generalist. Advocates of both sides must come to realize that the future environmental education programs and the future environmental workforce must be built on teams that call upon the knowledge of both the specialist and the generalist.

POST-SECONDARY ENVIRONMENTAL EDUCATION EFFORTS AND PROBLEMS

This section discusses the problems which Phase II sources identified within their own medium. The intent is to identify some of the problems and issues which were repeatedly mentioned by contact people. For complete information on any of the media, the reader is advised to refer to the volume of Phase II which corresponds to his particular area of interest.

Because of the conglomeritic nature of the Composite volumes, they have not been cited here; however, the issues which were brought forth are represented in the summarization of the section along with the general observations which refer to no specific medium, but rather to environmental education broadly.

Air

Programs in air quality were found chiefly in departments of environmental engineering, but also in those of chemical engineering, industrial hygiene, public health, and various others. The bulk of the programs described for Phase II were at the graduate level.

The main problem which confronts educators in this area is the lack of funding. During the years of the EPA training grants, institutions were able to establish the necessary facilities and instrumentation to conduct programs in air quality control. Since the flow of these monies has been discontinued, the quality of air programs and the number of students enrolled in them have been substantially eroded.

The University of Kentucky, for instance, used to have a large program in the days of the EPA grants. Student interest ran high because funding for their research was available. Once the EPA money stopped, the program declined dramatically. At the present, although the facilities and expertise exist at the University of Kentucky, there is not sufficient student interest to justify offering many courses.

Studies show that there has been a noted decline of the numbers and the quality of preparation of persons entering the air quality maintenance work-force – and this in the time of increased complexity in complying with the terms of the Clean Air Act Amendments of 1978. It is believed that a sufficient number of programs will become available once again only with the help of Federal financial support.

Solid Waste

Solid waste programs are not as varied as is typical of other environmental education areas. Most are highly technical and engineering-based in nature. Programs were described from departments in environmental health, civil engineering, environmental engineering/technology, waste management engineering, and sanitary engineering.

A number of problems were identified in the area of solid waste management. Of course, funding is most frequently mentioned. It was anticipated that with the enactment of the Resource Conservation and Recovery Act there would be a tremendous thrust in emphasis on resource recovery and waste-based power generation, but the funding did not come through as was hoped.

Several Phase II contacts reported that there was too much emphasis on training people for managerial positions and not enough on training people for operator positions. Most often persons who have jobs as operators have learned that trade on-the-job and by trial and error. It has been suggested that if a system of mandatory certification were initiated it would be possible to establish guidelines which would ultimately lend legitimacy

to the field. This would also address one other of the problems which confronts the field; that is, that the image of the profession is generally held in poor regard.

Potable Water

Enrollments in potable water programs which were examined for Phase II are fairly equally distributed at the various levels (associate level 32%, undergraduate 34%, graduate level 34%). It is believed, however, that enrollments at the graduate level are on the decline because of the attractive salaries which are offered to graduates at the bachelors level and because of the discontinuation of the EPA training grants. Most programs do enjoy a relatively stable enrollment level.

Concern was expressed by people in engineering programs over the nature of the general environmental sciences/studies programs. It was expressed that these "generalist" programs are far too general to adequately prepare a person to work effectively in the field, and that too much in the way of basic sciences had been sacrificed in the organization of these programs. Generalist programs appear to be declining.

Internships are most often found in associate and vocational/technical programs and in many cases are reputed to be the most valuable portions of the training experience in this field. Since they have been so beneficial at the vo-tech and associate levels, internships (i.e., co-ops, or any other hands-on work experience) are being successfully incorporated into advanced programs.

Wastewater

In large part, the comments which refer to potable water also apply to wastewater programs. Thirty-three percent of the programs report their enrollments to be increasing. Thirty-one percent of these programs are found at the associate level and 35 percent at the graduate level. Only 7 percent of the programs surveyed indicate declining enrollment levels.

Bachelors level graduates are offered excellent entry salaries in the private sector; consequently, it has been noticed that enrollments in graduate programs are declining. Another cause for this decline is that with the stoppage of EPA training grant money, students must now secure other sources of research funds.

Again, as in potable water, hands-on work experience most often accompanies programs at the associate degree and vocational/technical school levels. Internships, co-ops, and the like are being integrated into programs at the bachelors and graduate degree levels with increasing frequency. Often, they are considered to be the most beneficial aspect of one's academic preparation.

Since the passage of the Resource Conservation and Recovery Act, some sanitary engineering programs have reported a recent shift in emphasis from that of wastewater management to that of solid waste management and this may eventually impact the workforce availability, although persons responding on behalf of solid waste management programs have not mentioned this trend. Engineering persons have expressed concern about the quality of generalist programs which do not incorporate the basic sciences into their programs to a sufficient degree.

Noise

The Phase II noise report presented data on nine noise-related degree programs (seven in acoustics and noise control, two in audiology), as well as two non-degree noise training programs. Most degreed programs are at the graduate level. Acoustics programs most commonly train students for occupa-

tions including acoustical, environmental, industrial, safety, mechanical, and noise and vibration control engineering; noise control and pollution control specialists; noise control consultants; acoustical physicists; and environmental control technologists. Graduates of audiology programs are qualified to enter the occupations of clinical and/or industrial audiologists, and Occupational Hearing Conservationists (certified position). The largest portion of these become employed within the private sector.

While many students do gain research experience from assistantship money, the training grant is rarely available to the students of noise control programs. Academic personnel consider this an area of great need; they believe that the field is greatly underserved with respect to research funding.

Several sources noted a need to develop additional curriculum materials, specifically in acoustics, noise control engineering, ambient noise levels, monitoring noise, and the remediation of noise-induced hearing losses.

Nearly all of the officials interviewed believe that the future demand for professionals trained in noise control will increase (with judgements ranging from moderately to dramatically), because of the demonstrated needs. However, current growth

hindrances include the lack of regulatory legislation and the paucity of funds. The field of hearing conservation is also expected to grow, creating demands for trained personnel in industry and in health-related agencies. Awareness of adverse noise effects is increasing, which is demonstrated by the growing number of noise-related litigations. One source has stated, however, that OSHA will continue to lose cases because it often cannot prove that feasible technology is available. The continued development of technology requires continued effort, which requires the availability of funding.

Sources interviewed in Phase I indicated that persons qualified to work in noise control are difficult to locate; faculty members interviewed during Phase II also noted that graduates of their programs typically receive many employment offers from both the private and public sectors, and that many jobs in the field remain vacant for lack of qualified persons to fill them. Given the Phase I projections and the educational programs' dependency on additional financial support and legislation, the likelihood that job market demands will be met within the next three to five years does not appear to be good. This situation will most certainly retard progress in controlling environmental noise, and noise exposure in the work place.

Radiation

Forty-one percent of students enrolled in radiation related programs are at the bachelors level; 30 percent at the masters. Ninety-one percent report their programs to be stable or growing, with the principal increase occurring at the masters level. Foreign enrollments are increasing dramatically. The Pennsylvania State University's Department of Nuclear Engineering has a foreign student enrollment of 50 percent.

Image is an area of considerable consternation among programs concerned with the use of radioactive materials. While the subject is becoming better understood in many areas, others have made little progress with regard to improving their status on campus. This hampers efforts to recruit students at the associate degree and vocational/technical institute levels particularly.

There is no shortage of occupational demand for persons in the fields related to radiation. Demands are anticipated in radiological monitoring, nuclear waste management, and nuclear medicine. Of particular worth in mentioning is the vast wasteland of instruction and materials for instruction in the area of handling radioactive waste materials. Very few learning institutions consider the topic

at all, and fewer still offer a specific course devoted to the subject. The University of Tennessee's Department of Nuclear Engineering reportedly was planning a curriculum for a specialty option in fuel management and radioactive waste materials handling and disposal, but no date for anticipated start-up was available.

Energy

Overall, the picture of the energy education field is healthy and productive. Increasing public awareness of America's condition respective of energy is having a positive effect on these programs. Phase II researchers met with representatives of programs in nuclear engineering/technology, mining engineering/technology, petroleum and natural gas engineering, geology, energy engineering, and policy and management.

Some nuclear engineering programs noted that the nuclear program on campus has become more accepted among their students. This is thought to be an indication that public opposition to nuclear power plants may be wanning and that the current slow down on power plant construction may be overcome with a resultant increase in jobs in the field. Others were not so optimistic and felt

that demand for graduates in this field would remain stable. Still others contended that employment potential for graduates in this field is growing steadily and has not suffered in the recent past.

Schools in major coal mining areas (e.g., West Virginia, Kentucky, Pennsylvania) noted hostility toward anything or anyone labeled "environmental" because of perceived threats to the demand for graduates of their programs. That the coal companies provide the major sources for student support and programs, and that they must deal specifically with evertightening environmental regulations governing their practices appears to foster this fear.

Energy management and analysis was considered to be among the most crucially needed areas to be developed in the near future and, consequently, most promising for employment opportunities. Others noted that programs with teaching and research commitments to alternative energy sources and technologies are only now coming into their own. Feelings were mixed as to the future for such programs, but it was clear that without substantial funding for these endeavors there would not be any large scale effort made to develop programs in the alternative energies. There was frequent expression though, of the need for an

expansion of programs which are specifically designed to train/educate experts in these areas (e.g., solar, geothermal, wind, etc.) of alternate energy technology.

Pesticides

Workforce availability in both pest management and toxicology is far more limited than is the number of positions which are open. Environmental toxicology is described as a "burgeoning field" and the existing training and interest in pesticides and related topics are considered excellent with regard to job availability. Numerous sources indicate an increased need for college-trained personnel, and yet, the actual number of available programs has been decreasing over the past eight years. It appears that the mandatory certification for applicators has not resulted in increased interest in college level education for this industry.

Topics which program officials feel need greater coverage are integrated pest management, food and fiber, general pest control, and a greater quantification and specialization with regard to the use of all agricultural chemicals. An increasing number of growers are realizing that chemical pesticide usage is not necessarily the most effective mode for limit-

ing pest populations, in addition to being an extremely expensive method for control, and would find the dissemination of integrated pest management information useful.

The Pennsylvania State University has tried a number of programs for the pest control specialist. Robert Snetsinger (Bruce Shank, 1977) reports that, "the technology (two-year) programs are failing because the pressure to get into college is not as great as it once was." Snetsinger believes that the trend in pest management programs is toward entomology degrees with training experience in the field of pest management. Short courses are receiving a great deal of attention now, but they have the goal of teaching applicators the basics and little more. Because the pesticide applicator is so grossly untrained, there is a resultant lack of occupational satisfaction leading to high occupational turnover.

Regarding environmental programs broadly, sources consistently indicate the need for education programs which provide instruction in the necessary technology for the care of the earth, but caution that the future lies in the level of governmental fiscal commitment. An official of one program in rural toxicology perceives past federal action on the problem of toxic substances' use as being

much like trying to use a "sledgehammer to drive a tack." The same individual feels strongly that the general population needs to be reminded of the seriousness of environmental matters, and that we, "presently need a shot in the arm like Rachel Carson and Earth Day gave the movement in the late 60's."

It has been expressed that the amount of funding put into programs relating to food and fiber production (including pesticides usage) is too low. It is believed that this lack of financial support is the direct outcome of a false sense of security as to the nation's ability to produce food and fiber. If there were a scare as to our capabilities to produce food and fiber, funding might become more readily available. Appropriations to the U.S. Department of Agriculture are a little over a billion dollars, whereas appropriations to the U.S. Department of Defense and the U.S. Department of Health, Education, and Welfare are in the rough estimate neighborhood of one hundred billion dollars each.

A final comment was that there is a lack of appropriate teaching materials in the areas of pest control/pest management for the two-year level program.

General Comments

The withdrawal of Federal support was consistently mentioned as the factor which was most instrumental in the reduction of programs and/or number of students enrolled. Continued growth in the environmental areas was considered to be dependent upon forthcoming and consistent Federal support. Concern was expressed at the lack of time tested commitment to programs that are developed from "soft" money. More reliable and consistent support was needed. It was expressed also, that the U.S. Environmental Protection Agency has a bias in favor of engineering programs and those more technically oriented, and is not supporting equally important programs with sufficient commitment (e.g., environmental health).

Two year schools are often at a disadvantage because facilities, support faculty, and equipment are lacking, especially in comparison to large colleges and universities, unless they have received outside funding, as from the U.S. EPA. Schools are now feeling less able to organize their programs by specific environmental areas now that training grants are no longer as plentiful as they once were.

Futures of some programs look strong because of mandatory professional registrations (e.g., waste-

water, potable water, etc.). Professional registration in those fields which do not require it (e.g., engineering and certain areas of radiation technology) are strongly encouraged to adopt such systems because of the increased bargaining power in political contexts, as well as in securing employment.

During the course of Phase II, researchers noted that those programs which were apparently experiencing the most success exhibited most of the following characteristics:

1. There is an established continuity of tenured faculty leadership for environmental studies and/or health.

2. Volunteer programs dependent upon faculty and administrators with part-time commitments are avoided. The environmental program has separate departmental or equivalent status.

3. New courses with occupation-linked content are implemented expeditiously subsequent to assessment of need and student demand.

4. The teaching program is oriented around environmental problems appropriate to the location of the campus.

5. The program content is rigorous and course content tends to be integrative to the

point of interdisciplinarity as opposed to a multidisciplinary appraoch.

6. An internship or applied study term is required or a frequently exercised elective.

The Environmental Internship

Industry and education need to align their efforts to establish internships which give marketable skills priority, and also to ensure a commitment that graduates with the skills they have identified will be employable. Industrial advisory boards have proven to be very helpful, not only from the public relations point of view, but also for placement of graduates. Applied study/internships are encouraged because of the professional contacts which result, the "hands-on" potential, and the valuable work experience. These experiences are often considered to be the most worthwhile and successful aspect of a given program. The following discussion of internships in general is included because of the attention these kinds of experiences are receiving on a large scale.

The internship is an idea which many programs are seriously considering as an alternative approach to the traditional academic patterns. It

is unique in that this addition to programs is not only occurring at the two year level or in the vocational/technical institute as it has in the past, but at the bachelors and graduate levels as well. The internship has particular relevancy to industry and it prepares students for entry-level occupations much more appropriately than can be achieved in the classroom setting.

Many industries invest a minimum of six months to a year in the entry level preparation of their employees, and the internship all but eliminates the need for such an extensive (and expensive) orientation. The internship affords the industry to observe the caliber of work of the intern and gives the business the opportunity to preview the candidate before making the commitment that is necessary when a company takes a new person on board as a permanent employee. They have the opportunity to guarantee themselves the quality of employee that they desire with a minimum of financial commitment.

During the Phase II of the NE/EWA the internship was a factor of interest to researchers. The table which follows presents data regarding the utilization of internships for the programs included in that phase of the study.

TABLE I
NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT
INTERNSHIPS BY MEDIA AREA

Media	Total No. of Programs	Internship Yes	Internship No	Percentage requiring Internship
Air	48	19	29	40%
Energy	31	29	2	94%
Noise	17	4	13	24%
Pesticides	34	12	22	35%
Potable Water	101	50	51	50%
Radiation	25	17	8	68%
Solid Waste	20	3	17	15%
Wastewater	105	56	49	53%
Composite	130	68	62	52%
TOTAL	511	258	253	

Source: National Field Research Center, Inc., A National Environmental/Energy Workforce Assessment, Phase II.

It is interesting to note that no adverse comments were made to Phase II interviewers regarding internships. Many educators and several persons in the private sector expressed a desire to greatly expand and to formalize internship arrangements.

ENVIRONMENTAL WORKFORCE TRAINING PROBLEM AREAS AND RECOMMENDATIONS

Although the need to prepare for the middle and long-term future is critical and deserving of careful planning, the problems of today and the immediate future often seem overwhelming. Public agencies and industry need well-trained people now. It is unrealistic to expect universities and colleges to do an abrupt about-face and begin turning out highly specialized people at the bachelor and masters level. The need for technicians with highly specialized skills is not expected to diminish. The "retrofitting" of the education system's products will remain the employers' responsibility.

While the employers are struggling with specialized training, the schools are simultaneously struggling to maintain quality and variety in times of more restrictive funding and dropping enrollments (the war babies have graduated).

The position of the U.S. Environmental Protection Agency in the cooperation of government, industry, and the academic community toward the goal of achieving and maintaining an adequate supply of a well-educated, well-trained environmental

workforce is critical. The Agency's role as a catalyst is recognized and emphasized in the remarks of Dr. Robert W. Zeller, Director, Municipal Operations and Training Division, Office of Water Program Operations, U.S. EPA, before an audience actively involved in environmental workforce problems at a Rensselaer Polytechnic Institute sponsored conference, October 14, 1977.

Dr. Zeller's opening comments included the following:

"...[The] concept of partnership and cooperation is one that is paramount to the development of effective environmental education and training programs. We have recently experienced an enormous growth in the technology and information related to environmental problems and solutions. New laws and regulations for controlling pollution and protecting the public health and environment have been enacted that force us to reevaluate our social, political, economic and environmental priorities. It is important in these times for an agency like the Environmental Protection Agency to be reasonable, rational and realistic in addressing its environmental responsibilities. In this regard, environmental education and training is one important responsibility that deserves EPA's serious consideration." 10

The National Academy of Sciences study, Manpower for Environmental Pollution Control, Volume V, includes several recommendations germane to the problems surrounding the development and maintenance of a well-trained, well-educated environ-

mental workforce. Although the emphasis is upon the role of the U.S. EPA as a partner of state agencies with pollution control and abatement missions, business and industry and the education community are considered.

Some of the NAS Problem Area descriptions and Recommendations are reproduced in succeeding sections. Although they were presented in the NAS report as separate, distinct entities, the problem areas are subject to the same difficulties characteristic of the environmental education and training topic as a whole. No aspect can be isolated and dealt with unilaterally. The interrelationships are intricate. The broad spectrum of emphases and activities addressed in the NAS recommendations accompanying the problem areas reflects the complexities involved.

The following NAS Problem Area descriptions and Recommendations should be considered in tandem because of the close relationships. They are placed in context with findings of the National Environmental/Energy Workforce Assessment Phase I and/or II research which are especially pertinent. Additional relevant and supportive material is included where appropriate.

The National Academy of Sciences Recommendations No. 11 Priority of Manpower Policies 11 *

Problem Area

The emphasis placed by EPA on manpower development has diminished since the Agency's inception. This practice shows the low priority given the manpower aspects of the pollution control effort.

Recommendation

The Committee recommends that the Congress clarify its intent for environmental manpower development and training activities in existing legislation and provide EPA with a clear directive concerning its manpower and training authority.

The importance of manpower needs should be recognized by Congress and the Executive Branch and appropriately reflected in the Agency's budget. Manpower planning and training should be adequately funded, and there should be no diversion of manpower planning funds to other activities.

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* The numbers and texts of these problem areas and recommendations correspond to those which appear in an internal U.S. EPA memorandum dated September 26, 1978.

To define and focus environmental manpower responsibilities in EPA, we recommend that a high-level (sic) group be established within its headquarters with representation from the regional offices to insure adequate manpower planning and development. This group should coordinate and supplement the activities of manpower planning and training staffs in the program areas of air, water supply, wastewater, solid wastes, and other program elements.

National Environmental/Energy
Workforce Assessment Commentary

Direct training of environmental personnel, however, is definitely not the primary function of EPA's environmental education and training programs. In water pollution control, for example, the EPA is trying to limit our direct training role to highly specialized course work not available elsewhere...and primarily for EPA and State program personnel or for training of instructors.

In addition to direct training activities and the IRC [Instructional Resources Center] type of instructional resource coordination activity, the EPA is devoting an increasing percentage of our training budget into development of course work and course packaged for delivery by State training centers, educational institutions, and others. Some of this course work development EPA is funding cooperatively with other agencies. 12

Dr. Zeller's comments address the issue directly. The following excerpts from NE/EWA Phase I state reports leave little room for doubt as to the States' perspectives on this cornerstone problem area. The excerpts are presented by media area; they were selected for use because they are representative of the genre of statements found throughout the Phase I reports. [13]

Air

Maine

The needs for training are intense, and program officials would like to see EPA implement a training strategy which would: 1) not impose financial burdens on state program operating expenses; and 2) provide for a more effective delivery of services despite geographical location or numbers of employees.

Pennsylvania

The Bureau also takes advantage of training offered by EPA. Program officials indicated,

however, that it is sometimes difficult to register Bureau personnel for some of these courses due to limitations on class size.

South Carolina

Professionals in the Bureau of Air Quality Control have determined specific training needs that currently are not being met by any available source. These persons feel the need for courses relating to troubleshooting for monitoring equipment and courses that teach operating characteristics of pollution control equipment. Many of the training courses that are available to personnel teach theory, but very little practical application, and do not assist personnel in keeping up with the latest developments and technologies in the field.

Tennessee

It is notable that state officials have indicated that professional and technical courses currently offered through state colleges and universities are inadequate to satisfy the training needs in air pollution enforcement, source sampling, visible emission, and meteorology.

Another source of valuable training in air pollution control has been the EPA Air Pollution Training Institute courses. The partici-

pants have generally rated them highly; however, the courses are considered to be expensive, not readily accessible, and sometimes overly technical.

Washington

It has been indicated by professionals at the State level that EPA seminars are good in content, but the high cost of these seminars severely restricts the attendance of personnel who are in need of training. It is felt that a reduction in tuition fees and the addition of travel assistance to personnel in outlying areas would develop higher attendance and more effective results in seminar training programs.

Solid Waste

Connecticut

Due to EPA's wealth of information, it has been the consensus of opinion, not only in Connecticut but also in the other five New England states, that the frequency of these technical and training workshops should be increased considerably.

Kentucky

Because of budget restraints, the Division has had to cut back on training offered to its personnel.

New Hampshire

Formalized training and/or certification for state solid waste personnel is currently lacking, although it is the consensus of opinion that all professionals should be engaged in some sort of formal continuing education program. The reason behind this situation is the lack of available funds to finance such training as well as the absence of such curricula within the state...the major concern of New Hampshire's Bureau of Solid Waste Management is directed toward the relative absence of continuous technical assistance from EPA.

New Mexico

Training in the field of solid waste in New Mexico has been severely curtailed by the EIA. This is due to a lack of personnel for this function...during the first five months of 1976, on the average, fifteen percent of the time was allocated to training. During the last seven months of the same year, this effort declined to a negligible percentage of staff time.

Potable Water

Minnesota

...many of the smaller utilities cannot afford the expense of travel and tuition to training courses. Consequently, many operators of the smaller utilities are running the systems with insufficient background and training. Second, for the state regulatory program, providing effective training materials has been a problem insofar as it has been difficult to find or develop materials with the proper balance of theoretical and practical content...

Mississippi

Employees are occasionally sent to EPA courses that are offered out-of-state. This activity is very limited, as travel budgets are small.

Ohio

The use of EPA-sponsored upgrade training programs has been reduced because of budget limitations.

North Carolina

The Water Supply Branch is currently operating on a very tight budget and additional allocations made now for training would overtax the budget.

Wastewater

Kentucky

For technical upgrade training, the Division has relied upon EPA courses offered out of the training center in Cincinnati, Ohio. However, tuition rates have been imposed which lower the number of State personnel that are able to attend. In addition, the Division feels that courses are needed for its personnel that are not available through EPA.

Massachusetts

...DWPC would like to see EPA open up the Cincinnati Training Center again to a level and variety of courses which would truly meet the expanding educational needs of those currently employed by DWPC.

Missouri

Many of the operators who run the smaller rural utilities have insufficient background and training for their jobs, and many of these utilities cannot afford the expense of travel and tuition to training courses.

New York

It should be pointed out that federal support of workforce development programs has been commendable, but has not begun to keep pace with the needs generated by P1 92-500.

North Carolina

Training for staff of the Water Quality Section is considered by State officials to be presently inadequate. Training that has been offered for staff has been of an informal nature and infrequent.

Rhode Island

A greater emphasis in providing training resources in Rhode Island should receive the attention of EPA if the treatment plants currently being constructed and upgraded in the state are to be properly operated in the next five-year period.

South Carolina

Upgrade training opportunities are offered to wastewater employees, and although EPA technical courses are offered, the combination of required tuition fees and State budgetary limitations prohibits as much usage of these courses by employees as is desired.

South Dakota

Due to budgetary constraints the training staff is quite limited regarding out-of-state travel.

Vermont

Training for agency personnel involved in the state's wastewater program is limited due to a lack of funding.

Radiation

State regulatory agencies rely on agencies and/or organizations other than EPA for training. A few respondents indicated that the training is excellent but lacking in application to specific environmental problems.

Noise

The consensus is that there are no formal noise training programs designed for and suitable to the needs of noise control and abatement personnel. Short courses and workshops are attended when available.

State training programs are experiencing great difficulty. Program personnel are looking toward U.S. EPA as the only plausible source of aid in terms of money and program content support. There is an obvious disparity as to the perception of the agency's role. EPA's position must be made

clear to state personnel. If the agency maintains its present stance, it must increase its efforts as a facilitator in the provision of adequate training opportunities.

The National Academy of Sciences Recommendations No. 5 Charges for Training [14]

Problem Area

EPA's role in conducting training programs in pollution control for personnel not employed by EPA and the charges to participants in these programs have been controversial. These charges have adversely affected participation in the training programs, particularly by state and local employees. Various actions have discouraged EPA from providing direct, specialized instructions. Nonetheless, a need exists for the training of instructors and a capability for the development of training materials.

Recommendation

The committee recommends that EPA make a major effort to develop local institutional arrangements to meet specialized training requirements. EPA should continue to develop training materials where appropriate, and to train instructors. Involvement in direct training should continue on a limited basis. Since participation is constrained when fees are imposed, the Committee recommends that EPA eliminate fees for these training programs.

National Environmental/Energy
Workforce Assessment Commentary

Interviews conducted with state agency employees during Phase I of NE/EWA revealed that fiscal restraints are precipitating adverse effects throughout the wide spectrum of environmental workforce training activities.

Agency personnel training, in terms of quantity and often quality, has nose-dived in several states. Table II indicates, by media area, (1) the instances in which general fiscal cut-backs were cited as a significant deterrent to professional training and, (2) the number of programs for which tuition fees had imposed severe limitations on the number of personnel attending EPA courses or had curtailed such attendance altogether.

TABLE II

FISCAL RESTRAINTS AND TUITION FEES AS MAJOR DETERRENTS TO STATE PERSONNEL TRAINING

	NUMBER OF STATES	
Media Area	General Fiscal Difficulties	EPA Tuition Fees
Air	15	13
Noise	2	—
Pesticides	1	—
Potable Water	9	5
Radiation	9	—
Solid Waste	9	1
Wastewater	8	5

Sources: **National Environmental/Energy Workforce Assessment, Phase I State Reports.**

In the course of the interviews, no specific question regarding tuition fees was asked; the effects of the imposition of tuition fees were discussed only after the matter had been broached by agency personnel. It is reasonable to assume that additional states may be experiencing difficulty supporting EPA course attendance, but respondents did not indicate so because they were not asked directly.

Obviously, tuition fees are a serious impediment to agency personnel participation in EPA courses.

General fiscal problems were indicated to impact training for agency personnel in the following manner:

1. Out-of-state travel funds have been severely restricted or eliminated for agency personnel in many states. Travel restrictions are most severe in the Northeast. Several states have a very limited or no budget for out-of-state travel. Although other states, particularly in the West, have no specific ban on out-of-state travel for agency employees, the greater distances required to reach training facilities such as Research Triangle Park in North Carolina, Water Environmental Research Center in Cincinnati, or Oak Ridge, Tennessee, increases the relative expense of such travel which effectively reduces travel opportunities.

2. Formal in-house required initial and upgrade training programs have been eliminated, condensed or are no longer being considered for implementation. Many state agency divisions relied heavily on EPA or other federal agency training offered a significant distance away. Others relied on or supplemented formal training with contractual arrangements with universities or consultants. Money is not available to continue much of this activity. On-the-job training is becoming increasingly informal and narrow.

The effects upon training offered by agency personnel to other segments of the environmental workforce are equally distressing:

1. Several programs have reduced training staff.
2. Fewer agency sponsored courses are available.
3. The frequency of agency sponsored courses has been reduced.

Fiscal constraints are a significant ingredient to adequate training opportunities and participation. Elimination of tuition fees for agency training is an essential first step in alleviating the problem.

The National Academy of Sciences Recommendations No. 12 Manpower Planning [15]

Problem Area

Leadership for planning and developing a national manpower program for environmental pollution control logically rests with EPA. Success will depend on the uninterrupted availability of specialized, highly-trained professional manpower to manage national pollution control programs and to conceive, design, construct, and monitor the complex systems needed to meet mandated standards.

Recommendation

The Committee recommends that EPA present to the Executive Branch and Congress a comprehensive program of support for the development of professional and subprofessional manpower and operators. This program should be appropriate to the legislated goals of controlling environmental pollution. Such a program should include a long-term strategy for environmental manpower development based on manpower planning and using the most appropriate educational techniques. The manpower program would be implemented at the federal, state, and local levels under the leadership of EPA.

An environmental manpower impact analysis should be made to assure that the professional and highly-trained subprofessional manpower required to implement environmental legislation can become available within the prescribed time. This thorough assessment of manpower requirements should be done when legislation is drafted and hearings are held rather than after enactment of the legislation.

EPA should use these impact analyses as a basis for making recommendations to Congress and the Executive Branch concerning programs required to avoid shortages in the manpower necessary to carry out the proposed legislation.

The many skills required to carry out the programs and to operate control facilities at their designed capacities require that manpower factors be considered in all phases of program development and operation. Increases in the manpower supply in some specialized fields may not be sufficiently rapid to meet the need within the mandated time. Shortages of trained manpower could result in inefficient plant operations and could waste capital investment and operating funds far in excess of what is required for adequate manpower development and training.

National Environmental/Energy
Workforce Assessment Commentary

Our basic strategy for responding to environmental manpower needs is simple:

1. To translate estimated numbers and types of professional and subprofessional environmental personnel into the scope and nature of Federal, State, and local education and training programs required to help assure competency levels consistent with program needs and resources.

2. To help assure a beneficial and equitable sharing of available education and training resources consistent with the roles and responsibilities of Federal, State, and local governments, the educational community, and other public and private sector groups. To accomplish this through development and vigorous use of highly visible lines of communications among Federal, State, and local environmental agencies and between the environmental agencies and the educational/training community.

...the Environmental Protection Agency has also provided academic grant funds to educational and non-profit institutions to train and educate individuals in response to recognize pollution control needs. Through this professional training grants program, institutions of higher education have been provided with funds to help develop a cadre of highly qualified pollution control experts. At the present time, there are 30 universities participating in the water pollution control professional training grant program.

In addition to the professional training grants program, EPA has an established fellowship program that provides graduate assistantships to State employees so that they may return to school on a full-time or part-time basis to obtain necessary education and training experiences. These individuals return to their State agencies to assist in carrying out Federal and State pollution control mandates. 16

Dr. Zeller's remarks underscore the agency's state of awareness of and concern for the implications of this problem area. They further illustrate the agency's concerted attempts to provide leadership in efforts to expand the available highly-trained environmental workforce through the support of workforce development with a major training grants program.

One recurring theme throughout Phases I and II of NE/EWA was the disparity between the perception of the quantity and quality of the avail-

able and near future environmental workforce supply from the perspectives of educators and current pollution control personnel. In many instances the discrepancies appeared to be prompted by miscommunication between agency personnel and academia. The former frequently indicated that post-secondary educators have little understanding of the specific knowledge area and skill level required for agency positions. The latter frequently countered that agency personnel often did not really understand the program content nor the reasoning which determined the content. Representatives of both sides often expressed a belief to the effect that if the other would just listen, appreciate the real nature of the problem, and act on that, the workforce supply would be sufficient and efficient. Neither side seemed to feel that such a reconciliation would be likely in the near future.

Another disturbing aspect of perception of the environmental workforce situation was that of great uncertainty as to future conditions and needs expressed by professionals long acquainted with the matter. The difficulty of predicting future legislation and federal agency posture and the resultant effects upon specific workforce needs was a shared problem of educators and agency personnel alike.

The success of assessing, planning for, and developing a program to provide a workforce supply adequate as to quantity and quality is dependent upon a reasonably accurate projection of federal legislative and agency activity. An uninterrupted availability of people to develop, manage and operate pollution control/abatement programs and equipment is dependent upon an accurate projection of federal emphasis well in advance of changes in needed educational and training specialties.

In the past, implementation of major federal legislation has been compromised by personnel "gearing up" after the fact. State agency interviews during Phase I revealed that implementation of NPDES was affected in this manner to some degree and that SDWA implementation was severely affected. The necessitated significant expansion of agency staff, especially with regard to the latter was often overwhelming in terms of locating and attracting persons with the requisite qualifications for good program conduct and in terms of future funding to maintain the support of the positions over the long run.

Sufficient lead time to prepare individuals for positions of responsibility (whether the preparation is in technical or managerial skills) is essential to successful implementation of future pollution control and abatement activity. The Agency should improve its ability to anticipate probable legislative action, the resultant enforcement posture, and the consequent workforce requirements. Further, the Agency should convey these anticipations to state and local agencies, the private sector and the academic community in a timely, definitive, and positive manner.

The National Academy of Sciences Recommendations No. 22 Assistance for State and Local Agencies [17]

Problem Area

Cooperation is needed among various levels of government and the private sector to assess environmental manpower needs and to plan cost-effective programs to meet them.

Recommendation

The Committee, recognizing that delivery systems for specialized training are largely in the hands of state and local officials, recommends that EPA pursue a three-part strategy to assist in monitoring and mobilizing these resources for pollution control.

1. EPA should provide technical assistance and grants to give state and local agencies the tools needed to plan for manpower demands in environmental protection;

2. EPA, state and local environmental officials should work with education administrators concerning special training programs. Careful manpower planning is essential in order to make the most effective use of all available resources; and

3. EPA should identify the gaps in state and local programs and prepare a national assessment of demand and supply. Working with the U.S.

Department of Labor, Office of Education, industry, and professional leadership in the development of programs to support state and local manpower activities.

National Environmental/Energy
Workforce Assessment Commentary

This is truly a multifaceted problem area. The aspect regarding governmental and private sector cooperation has been addressed directly in all three phases of the National Environmental/Energy Workforce Assessment. The findings and conclusions regarding the status quo do not reflect an atmosphere conducive to the successful implementation of the NAS recommendations. Private Sector Training Activities, a companion of this monograph prepared during Phase III, presents a more detailed summary specific to this problem area.

Briefly, Phase I activities regarding the private sector centered upon a study to determine (1) the strong and weak points of previous efforts in private sector environmental workforce assessment and projection and (2) the most feasible methods and goals to be pursued to obtain useful data in the future. The inadequacies of previous efforts are summarized in the subsequent NAS problem area discussion.

The concerns which determined the objectives of the NE/EWA Phase I study of business and industry were:

1. What method(s) should be used to obtain environmental workforce information from employers?

2. What conditions affecting the private sector or attitudes of management personnel interfere with obtaining information which can be translated into reliable data?

3. What size and other characteristics should a sample have to be representative of the industrial sector?

4. How consistent are definitions of environmental personnel among the various segments of industry and the public sector? 18

The Phase I findings specific to the private sector's role in environmental workforce assessment as it pertains to education and training needs include a discussion of conditions and attitudes within business and industry which promote an air of extreme cautiousness resulting in a disinclination to cooperate with various levels of government in any workforce assessment activity.

Phase II of NE/EWA includes a descriptive report of private sector environmental workforce training activities. The extent and sophistication of these private sector efforts clearly reflect the dissatisfaction with parallel public sector and academic efforts. The prevailing attitude is that the only way to ensure training appropriate to private sector needs is to conduct that training in-house.

Since the creation of the U.S. Environmental Protection Agency, Congress has been aware of the needs and considerations to authorize the Agency to address workforce problems in the area of pollution control and abatement. For example, the training and development of personnel are provided for by the Federal Water Pollution Control Act, and Amendments of 1978 (P1 95-976). Substantial personnel development projects are authorized under Section 104 of the Act which addresses training for the operation and maintenance of waste treatment plants. Sections 109 and 111 lend further authority to the development of personnel for the operation of wastewater treatment plants. Under these two Sections, post-secondary undergraduate students may be awarded scholarships for preparation in these occupations.

The Safe Drinking Water Act and Amendments of 1978 (Pl 95-190) likewise explicitly provide for the public health occupations involved in providing safe drinking water. The U.S. EPA may make grants to educational/training institutions or public agencies for this training.

The Clean Air Act and Amendments of 1978 (Pl 95-95) provide, also, for personnel development and training in the prevention and control of air pollution. Under the Clean Air Act a number of training options are available including: awards of grants and contracts to public and/or private agencies; establishment of research fellowships; and, provisions for actual direct training grants.

The Resource Conservation and Recovery Act (RCRA) of 1976 provides for the expanded replacement of the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970. This Act also provides for workforce development and/or educational/training activities.

Final examples of legislation which provide for education and training for personnel are the Federal Insecticide, Fungicide and Rodenticide Act of 1947, Federal Environmental Pesticide Control Act of 1972, the Federal Pesticide Act of 1978 (Pl 95-396) and the Toxic Substances Control Act of 1976 (Pl 94-469).

Although not a comprehensive listing, the preceeding examples of environmental legislation illustrate the intent of Congress to authorize education/training to ensure an adequate workforce supply for environmental pollution control and abatement.

Grants awarded under these provisions have been instrumental in the assessment and development of the workforce critical to effective implementation of the corresponding legislation. State and local personnel interviewed during Phase I of NE/EWA who were directly involved in activities dependent upon such grants were consistently favorable in their comments as to the value of the grants in intent and implementation. Several of these persons expressed concern that curtailment of grant dependent programs would seriously impair future pollution control and abatement efforts.

Agency/Academic Cooperation in Special Training Programs

Similarly, we need to establish recognized lines of communication among EPA, State agencies, the educational community, and the private sector to assure efficient use of available resources for educating and training EPA, State, and local environmental pollution control program personnel...also, for determining additional resources needed to fill the gap between present and required levels of environmental education and training program capabilities.[19]

The National Field Research Center findings are consistent with the second recommendation in the problem area. However, many of the conditions which underlie the recommendation are indicative of the difficulties that are to be anticipated in future attempts at cooperative endeavors. A previous section of this monograph contains comments of state agency personnel regarding the shortcomings of academic training. Those comments are apropos to this problem area.

There exists further, more tangible evidence of the nature and extent of the disparities between the emphases, approach and goals of the academic community and those of environmental agencies. The establishment of training centers not wholly under the control of the states' educational systems is a case in point. Such training centers include:

San Marcos Training Center (California)
Center for Training, Research and Education for Environmental Occupations (Florida)
Water and Wastewater Technical School (Missouri)
Tennessee State Operator Training School
New England Regional Wastewater Training Institute (Maine)
Environmental Resources Training Center (Illinois)
Virginia Wastewater Treatment Plant Operator Center

It is important to note that although these centers are more or less independent of the regular

educational/training delivery systems, there are several cooperative agreements and arrangements which substantiate the willingness of cooperation. The key difference is the shift in the control of the facility and thus, a shifting of the points of compromise to be considered.

By and large, state agency personnel are pleased with the trend toward training centers. It remains to be seen if such centers will continue to "make the most effective use of all available resources." Many state agencies feel that the arrangement with state community college systems is the preferable route. Exclusion of the educational community with the physical facilities and experience, thereof because of inabilities to cooperate effectively now, could prove to be most unwise. Training and educational cooperation between the public sector and the academic community is essential. Under less than ideal economic conditions neither can afford anything less than the fullest, most sincere efforts to develop and operationalize programs which minimize redundancy and maximize outcomes of mutual benefit.

The use and promotion of programs and teaching materials developed by professional and occupational organizations is illustrative of an area in which academic/agency cooperation has been outflanked.

Organizations most frequently noted in Phase I for substantial contribution to training in terms of courses and instructional materials included:

–The Air Pollution Control Association

–The American Water Works Association and state affiliates

–State Water Pollution Control Associations

Many state pollution control and abatement agencies make heavy use of courses and workshops offered by other state agencies in training of staff and for instructor training.

With regard to gaps in state and local programs, other than the problems directly attributable to limited education/training budgets, the most relevant NFRC findings are reported in a companion Phase III monograph, Salaries and Attendant Problems of Public Sector Employment. That monograph concludes:

Employee turnover rates are sufficiently high among environmental pollution control and abatement agencies to be disruptive to task accomplishment essential to fulfillment of agency mandates... State agencies are in a highly competitive situation. Any disadvantage to agency employment is of major significance because employment opportunities abound elsewhere. Salary levels demonstrably well below the average for the professional field are

critical impairments to state agencies' efforts to attract and retain qualified professionals...

Pollution control and abatement efforts are weakened by state agency personnel problems. Programs of national scope with the highest Federal priorities are affected. Severe shortfalls of anticipated goals may result.20

The inordinately high turnover among agency employees due to relatively low salary is a primary cause of training and education problems simply due to the increased numbers of persons involved and the necessary repetitive efforts in basic level training at the expense of more advanced training for more experienced personnel.

At least one state (Ohio) meets some of its training needs through a contractual arrangement with a non-profit organization. This and any similar arrangements which may exist should be examined carefully to determine if this method may be a practical solution to delivery of training on a large scale.

Much of the difficulty attributable to faulty assessment of workforce needs, unrealistic non-cost effective workforce development programs and ineffective delivery systems is due to an abysmal record

of cooperation among the various entities involved. In turn, the lack of cooperation is traceable beyond occasional hostility to failures in communication.

Better projection of actions and needs and improved two-way communication between the agency and others is imperative. A fuller understanding of difficulties encountered and anticipated by each entity is essential to effective program implementation.

The National Academy of Sciences Recommendations No. 39 Projection Models [21]

Problem Area

Projections of environmental manpower supply and demand have been subject to a number of deficiencies. Most of these projections have been aggregated at a national level, makes (sic) their use risky, because the comparison of projected supply and demand ignores distances between geographic sources of supply and points of demand.

Recommendation

The Committee recommends that EPA increase its use of manpower analysis tools that are available both within and outside the Agency for a better understanding of future manpower requirements. Data sources and projection models from the National Science Foundation, Bureau of the Census, and Bureau of Labor Statistics should be used more extensively.

EPA should also strengthen its support for state and local manpower planning. Support should be encouraged from other governmental agencies interested in local labor market planning in order to develop an adequate data base. Emphasis should

be placed on a detailed examination of portions of an overall manpower projection model, concentrating on more local or regional problems or both. Efforts should be made to identify those occupational specialities that are critical to effective pollution control.

The Committee further recommends that EPA itself improve its environmental manpower projection methodologies by relying both on staff expertise and advisory committee evaluations. These projections should be disaggregated to specific job groups in each categorical program and to sufficiently small geographic areas to be of use to state and local environmental manpower planners. Much greater emphasis should be placed on accounting for those behavioral characteristics of the environmental labor force that are likely to have a bearing on imbalances between supply and demand, particularly at state and local levels.

Demands for environmental manpower are strongly affected by legislative action, the resulting EPA regulations, and the national economy. Thus, demand projections, particularly over long periods of time, are highly conditional by nature. The critical importance of policy and economic assumptions to accurate projections must be kept in mind in as-

sessing the validity of such projections. Still, projection models can identify possible imbalances based on the best available information, particularly for incremental analyses involving program changes.

The National Academy of Sciences Recommendations

No. 44 Environmental Manpower Requirements in the Private Sector [22]

Problem Area

Traditionally, larger industries have used in-house and on-the-job training to develop manpower to solve environmental problems and have relied on educational institutions to provide basic education. Various small businesses, on the other hand, may find themselves confronted by highly technical problems but with no reliable access to needed technical advice on problem-solving capabilities. Therefore, additional assistance must be provided to these firms as well as to individuals.

Recommendation

1. EPA should analyze manpower needs for industry and the private sector as these needs are influenced by existing and proposed environmental legislation.

2. EPA should obtain the participation of private industry in its training mission for environmental manpower. More specifically, student co-operative programs should be extended to potential

employees, and continuing education efforts should be enhanced. Private industry should be encouraged to take a more active role in advising the appropriate educational institutions, environmental agencies, and EPA in their assessments of training requirements.

3. EPA should cooperate closely with the private sector to design and conduct a long-term personnel study to produce the data necessary to assess current personnel use and to project future manpower requirements and training needs.

4. Congress should appropriate funds to enable local agencies and organizations to provide technical assistance and accurate information to farmers and small businesses unable to afford technical manpower to carry out the objectives of environmental legislation.

National Environmental/Energy Workforce Assessment Commentary

The National Environmental/Energy Workforce Assessment Phase I report, Business and Industry, includes a discussion of specific deficiencies of several attempts at projection of environmental manpower supply and demand in the private sector. A synopsis of the salient points of that discussion follows:

Scope

Previous studies of the industrial environmental workforce were components within projects of a much broader scope or pertained to only one pollution control area.

Data Bases

Premises and assumptions employed to formulate data bases varied significantly from study to study.

Several studies begin with the premise that a definitive relationship between pollution control expenditures (primarily capital investment) and pollution control workforce needs exists...Methodology has been developed which uses capital expenditures, operation and maintenance costs, and research and development funding for base data in workforce needs projection. However, several unsubstantiated assumptions are incorporated into the methodology which are causes of concern as to the adaptability of the methodology to changing economic and regulatory conditions. A major potential flaw is the assumption of a direct relationship between pollution control capital investment and environmental personnel requirements.

No data are available specific to pollution control personnel which suggest an identifiable ratio of capital expenditures and employment. If such data are developed, it must be taken into account that the pollution control areas vary as to capital intensity; thus, a recognizable ratio of capital expenditure to water pollution control personnel is not readily adapted to air pollution control personnel.

Studies which employ capital expenditures as an indicator of environmental control personnel requirements are likely to produce projections which differ substantially from studies which begin with an assessment of the current workforce level from an "actual count" perspective.

Definitions

Uniform definitions to determine parameters of "environmental personnel" were not used.

Samples

Samples were small and representativeness often not substantiated.

These inadequacies contribute to the following problem areas which make much of the data obtained in previous studies of questionable value for planning and decision-making:

1. The studies in which the private sector represented but one component produced data which were, in many respects, too scanty from which to formulate projections of reasonable accuracy.

2. Data relevant to one pollution control area, as obtained in the single area studies, are often not applicable to other pollution control areas.

3. The range in scope of previous studies (from one pollution control area to the

full gamut of areas under the purview of the U.S. Environmental Protection Agency) is detrimental to comparability of data and projections from study to study.

4. The variety of data bases arrived at from disparate premises and assumptions further impairs the comparability of study results.

5. The absence of uniform definitions of "environmental personnel" is deleterious to comparability of studies and may be a source of inaccuracy within a study if adequate controls (such as uniform instructions to employers as to which employees to include in the data they provided) were not maintained.

6. Non-representative samples increase the disparity of data and projections among the studies and could lead to decisions based on inadequate or misleading information. 23

The effects of legislative action and the resulting EPA regulations upon demands for environmental manpower and the resultant need for education and training are underscored by the following remarks of private sector personnel recorded in the course of Phase I of NE/EWA:

"...major problem in dealing with the federal government in the implementation of federal guidelines and regulations has been the inconsistency of enforcement and information dissemination."

"We can't predict what they (the EPA) will do next, whether it's a new regulation, changing regulations, or deciding what to enforce, how. We can't make sound decisions about employment or anything else until we have better information about what their (the EPA) plans are." 24

The benefits of a better rapport, improved communications, and an atmosphere of openness and rational action on the part of the Agency and the private sector are well worth the effort indicated.

THE NECESSITY OF AN ENVIRONMENTALLY ENLIGHTENED PUBLIC

Naturally we need to train a sufficient workforce of practical ecologists and other environmental specialists in order to expand our knowledge of environmental processes and our impact on them and to plan effective solutions. However, a far more difficult problem is to educate citizens who are prepared to pay for the training and employment of these experts, who have a basic understanding of man's interrelationship with his environment, who understand and recognize environmental problems, and who are interested in and care enough about their environment to take action towards its preservation and enhancement. The future lawyers, bankers, legislators, industrialists, and teachers will probably determine the direction of our environmental actions. These are the people who will support them and help shape their actions. These are the ordinary citizens who will wield their votes, hopefully from a position of enlightenment.

It is quite clear that the police could not successfully enforce the law in our society if the majority of citizens were not law-abiding. If more than a few percent of our society were law-breakers,

our law enforcement agencies would not be able to cope with the amount of crime. The situation with the environment is very similar and unless the great majority of people are environmentally aware and as responsible to the environment as they are to the law, then those responsible for the regulation of our environmental impact will not be able to cope with the amount of crime. The situation with the environment is very similar; unless the great majority of people are environmentally aware and as responsible to the environment as they are to the law, then those responsible for the regulation of our environmental impact will not be able to cope. We have all grown up learning, from the earliest years, to respect the law and we have been taught the benefits and protections which the law offers those who abide by it. We have only begun to learn similar attitudes toward the environment. We are still at the stage of arguing over environmental matters and we are a long way from creating an atmosphere in which our children will grow up feeling as comfortable in their natural and man-made environment as they do as part of a well-ordered society. [25]

Currently, studies show that the majority of the American general public gives a high priority to environmental values. However, when confronted

with choices that may affect their immediate self-interest, many of these same people support environmentally harmful courses of action. The evidence indicates that although the public seems to be environmentally concerned, it hasn't built strong enough environmental values to produce a significant difference in the choices of most people, especially those who make the major environmental decisions that affect much of the nation. It also shows us that while a growing concern for the environment is reaching many people, very few are actually aware of the long-lasting and sometimes devastating effects of environmentally irresponsible actions.

Positive action taken by those who are environmentally caring decision-makers usually results from an enlightened self-interest. Instead of making decisions which would benefit only their own, usually restricted, personal interests, they also consider their neighbors, community, and the natural world before taking action. Instead of being preoccupied with the present and immediate future, they have widened their outlook to include the more distant future. This type of practice has been termed "environmental citizenship". Considering the impact of their decisions and living as responsible members of nature's system amounts to environmental citizenship in the same way that abiding

by the law, voting, paying taxes, and acting responsibly t ·vard the community constitutes political citizenship.

Unfortunately, environmental citizenship is practiced by few people who are in positions to make large scale decisions. Those who are doing so have their own personal set of values which vary a great deal from the present norm. When we look at the whole world system the environmental consequences of present actions take on even greater dimensions. The need for a universal application of an environmental ethic is imperative.

An environmental ethic must be incorporated into our decision-making processes, however, it must not interfere with our social responsibilities and obligations toward fellow humans. This ethic must be integrated into our ŏverall system of values and coordinated with our economic system. If it trys to override or ignore social values then it will ultimately fail. Environmentalists need to gain a respect for social values which they so often condemn. Because of their often radical attitudes toward environmental issues; these environmental purists often do more harm than good by failing to seek an environmental-social compromise which must be an integral part of environmental problem solving.

It seems that our society is hanging on to the belief that technology will eventually solve all of our problems. This line of hope is incompatible with both environmental and social ethics. It has become apparent through recent history that technological advancements have many times brought with them unforeseen and very harmful side affects. We are still in the learning process when it comes to knowing how to live within the natural cycles which will ultimately determine our future. Until we can forecast the effects of our actions on the whole biological system we must advance only with great caution. This applies equally to the engineer and the environmentalist.

Many attempts have been made to effect changes in our value system. The authors of the National Environmental Policy Act attempted to bring about a change of values in government decision-making by legally requiring environmental impact statements on all projects. Unfortunately it appears that this method alone has not made any major impressions on values. The so-called energy crisis of 1973-74 could have resulted in a fairly rapid national value change, and no doubt it did contribute somewhat to this effect, even if the change was short lived. Had our national political leadership perceived the

long-term nature and implications of the problem they may have led the population to seek less dependence on products based on scarce petroleum resources and to discover values which minimize consumption. However, the crisis was declared over despite its long-term dangers and as a result most of us have nestled back into our over-consumptive ways feeling a tentative false sense of security.

A slower but more permanent change of values can be accomplished through education. Whether it be formal education through the schools or informal public education principles and facts can be conveyed which will help to change our personal value systems. The practice of environmental ethics comes much more naturally to those who are taught to understand man's role in the whole ecological system. When this set of values is taught through factual learning rather than emotional experience it will produce a more balanced ideal from which to take understanding action.

As population pressures, resource depletion, and the effects of technology and material growth continue to threaten the earth's carrying capacity, the sense of values leading to an environmentally active citizenship will be increasingly important. A general public with an ingrown environmental

ethic could be more important than we realize. Decisions made on an individual basis, in all walks of life, will determine the longevity and quality of life as we know it. [26]

Environmental education in many forms has been a part of our educational programs through history. Direction and emphasis of such programs have varied a great deal, leading identification of environmental studies to a very broad and generalized scope. Subject matter which has been termed environmental has been taught in separate courses at all instructional levels and has been offered as part of other curricula as well. The overall effects of these often sporadic inputs into the educational system have ranged from emotional responses to local situations, to a wide-spread change of intellectual attitude over time toward the importance of environmental quality. A result of this variation is a vast array of meanings attached to environmental education.

During the past decade, environmental issues, and even the propagation of environmental education itself, have become increasingly prominent topics in the popular press and in professional publications. The quest for environmental quality has become a major concern of both the public and the political platform. It calls for a change both in our value

system and in our life style. In learning to live with and within our total environment we must begin to set quality ahead of quantity. Industry must be held accountable to society for things which have traditionally been classified as externalities, and business must become aware of the repercussions of continual change for the sake of novelty and temporary advantage. Research must be concerned with the social implication of environmental decisions, especially when the equitable distribution of socio-economic costs and benefits are involved. [27]

The educational system must take on the task of integrating a deeply rooted environmental consciousness into all levels of our social system. Educational programs must be developed which are coordinated, extensive, and pervasive. It is important to assist each individual to obtain an understanding of the environment, its related problems, and the interrelationship between the community and surrounding land. It is important to provide opportunity and intellectual and informational tools for individuals so that they may be effective in working toward the solution and prevention of environmental problems. This approach is the basis for environmental education. The environmental education movement has been defined in the following way:

"Environmental education is aimed at producing a citizenry that is knowledgeable concerning the total environment and its associated problems, aware and skilled in how to become involved in helping to solve these problems, and motivated to work toward their solution." 28

Since the 1970's a commonly expressed goal in the pages of professional journals has been the development of an informed society to bring about sound environmental policies. It is becoming evident that while highly specialized personnel are needed to bring about technological advancements in environmental quality control, there is also the need for more broadly based programs, drawing from many curriculum areas to enable the student to grasp the comprehensiveness of environmental issues. The U.S. Office of Education has stated: "It has now become impossible to make wise decisions about our environment without an understanding of economics, political science, sociology, and the humanities, as well as science."21 This is illustrative of the broad concept of environmental studies. The need to avoid conceptual isolation and over simplification in educational programs and environmental action is becoming clearly realized.30

While the popular media, governmental, industrial, and private agencies have publicized environmental issues, our public schools and universities have moved at a much slower pace in the development and implementation of systematic, comprehensive environmental programs. Many school practices do not presently support environmental education as multi-disciplinary. Continual obstacles such as duplicated efforts, inadequate resources, poor schedules and personnel shortages are amplified by fragmented responsibilities and notions of territoriality.

The Environmental Education Act was signed into law October 30, 1970. Funds and authority under that legislation were to function as a promotion agent within the U.S. Office of Education and to coordinate other governmental agencies and resources. Despite this legislative attempt, the pace for the development and implementation of environmental education is not likely to accelerate unless state and national budget and leadership support are increased. The present energy crisis may function as another catalyst to promote the support of present educational needs.

An article in the EPA Journal, "The Challenge of Environmental Education," by Mary F. Berry

and George E. Lowe, is an excellent description of the events leading to and the results of the Tbilisi conference. The article concludes:

> We need a total program of environmental education that covers both students currently in school and adults who have completed their formal education; such a program would provide an understanding of the interrelationship of global ecological balance to weapons of mass destruction, energy, resource depletion, environmental pollution and population density within the context of a viable economic system. An integrated national program of environmental education would involve a continuing education process from early childhood to adulthood, to be carried out by both the formal and non-formal educational institutions in cooperation with the international sector, the Federal, State and local governments and the wide variety of concerned non-governmental organizations.[31]

The implementation of such a total program of environmental education is a necessary step in the development of an environmentally enlightened public. A public so enlightened is essential as a base of support for sufficient funding to ensure the quality of environmental workforce for effective pollution control and abatement.

CONCLUSION

This monograph is by no means an exhaustive diagnosis of the problems permeating environmental education and training. Rather, the intent has been to survey current conditions and attitudes from the perspectives of those who must deal with the problems on a day to day basis. The U.S. Environmental Protection Agency, state pollution control and abatement agencies, business and industry, and academia daily make decisions which directly affect the other entities' efforts in environmental education and training. Each group is actively engaged in sincere efforts to alleviate problems; each faces a complex mix of conditions which compromise those efforts; and each has serious criticisms of the efforts of the others.

Salient issues and activities of common interest to these groups have been identified and discussed in the monograph. Two points of commonality emerged: 1) Undue emphasis or neglect toward any one area is likely to precipitate adverse effects upon other areas; and 2) a major problem, central to all, is that of communication. It is in the area of communications that significant improvements can be made swiftly and with great impact.

To the research analysts conducting the National Environmental/Energy Workforce Assessment, much of the communications on the topic of environmental education and training appeared to be of an adversary nature. Little improvement in any aspect of environmental education and training can be expected if representatives of the principle groups continue to address the issues by taking pot shots at the other groups. This adversary approach is often compounded by the insertion of an intermediary. That is, one group often criticizes another through a third party. Face to face discussions of the problems based on a common desire to arrive at mutually satisfactory solutions are rare.

Most disturbing to interviewers during Phases I and II of NE/EWA were the comments of people which rang with frustration and upon occasion, bordered on contempt for one or more of the other groups grappling with environmental education and training problems. The accounts of well-intentioned efforts which produced only moderate success or worse, abject failure, seemed to overshadow those efforts with sound results. Often it appeared that if a more open communication had been established before the implementation of a program, a greater degree of success would have ensued.

The participants in the planning, support and implementation of environmental education and training activities must become intimately aware and appreciative of the activities, needs, and problems of others similarly occupied. Only through such an awareness and appreciation can a rapport evolve which is essential to the success of all.

An atmosphere conducive to frank, constructive dialogue must be cultivated. The obvious catalyst for initiating this kind of dialogue is the U.S. Environmental Protection Agency. Blue ribbon committees, task force reports, and massive conferences with formal presentation sessions are not consistent with this approach.

Of far greater benefit would be Agency sponsored working dialogue sessions of small groups of persons actively involved in the various aspects of environmental education and training, conducted at the sub-regional level (participants should represent no more than a three-state geographical area to maintain the requisite integrity of common interest). Ideally, three such sessions involving the same people should be planned over a one-and-a-half to two-year period so that the initial dialogue may be followed up with discussions of assistance, progress and accomplishments.

REFERENCES

[1]Federal Interagency Committee on Education, U.S. Department of Health, Education and Welfare, Toward An Action Plan. A Report on the Tbilisi Conference on Environmental Education (Washington, D.C.: U.S. Government Printing Office, 1978), p. 1.

[2]National Field Research Center, A National Environmental/Energy Workforce Assessment, Phase I. Various State Reports and Interviewers' notes. (Iowa City, Iowa: National Field Research Center, Inc., 1977) pp. en passim.

[3]National Field Research Center, A National Environmental/Energy Workforce Assessment, Phase II. Various Reports and Interviewers' Notes. (Iowa City, Iowa: National Field Research Center, Inc., 1978) pp. en passim.

[4]Lester R. Brown, The Twenty-Ninth Day: Accommodating Human Need and Numbers to the Earth's Resources (New York: Norton, 1978), pp. 256-257.

[5]Melvin A. Eggers, "Where Education is Losing Touch," Business Week, September 15, 1975. p. 16.

[6]Brown, Twenty-Ninth Day, p. 257.

[7]Roderick Nash, "Logs, Universities and the Environmental Education Compromise", Current Issues in Environmental Education - II: Selected Papers from the Fifth Annual Conference of the National Association for Environmental Education,

April 25-27, 1976, ed. Robert Marlett. (Columbus, Ohio: ERIC Center for Science, Mathematics and Environmental Education, The Ohio State University), p. 17.

[8]Roderick Nash, "Goodbye Renaissance Road", Journal of Environmental Education (Spring, 1977) p. 3.

[9]Brown, Twenty-Ninth Day, p. 257.

[10]Robert W. Zeller, "Environmental Problems and Manpower Needs of Government...The Environmental Protection Agency Viewpoint and Programs." An address delivered at "Environmental Education: A Partnership Between Government, Industries, and Universities," a Conference sponsored by Renselaer Polytechnic Institute at Lake George, New York, October 14, 1977. p. 1.

[11]National Academy of Sciences, Manpower for Environmental Pollution Control, Vol. V. A Report to the U.S. Environmental Protection Agency from the Committee for Study of Environmental Manpower, Committee on Human Resources, National Research Council. Washington, D.C., 1977. p. 2. Problem area numbers and text for this and subsequent references are from an internal U.S. EPA memorandum dated September 26, 1978.

[12]Zeller, op. cit., pp. 7-8.

[13]National Field Research Center, Phase I, State Reports, op. cit., pp. en passim.

[14]National Academy of Sciences, op. cit., p. 8.

[15]Ibid., p. 2.

[16]Zeller, op. cit., pp. 4; 9-10.

[17]National Academy of Sciences, op. cit., pp. 3, 4.

[18]National Field Research Center, A National Environmental/Energy Workforce Assessment, Phase I, Business and Industry (Iowa City, Iowa: National Field Research Center, Inc., 1977) pp. 7-8.

[19]Zeller, op. cit., pg. 5

[20]National Field Research Center, Salaries and Attendant Problems in Public Sector Environmental Employment (Iowa City, Iowa: National Field Research Center, Inc., 1979).

[21]National Academy of Sciences, op. cit., pp. 5,6.

[22]Ibid., p. 9, 10.

[23]National Field Research Center, Phase I, Business and Industry, pp. 2-6.

[24]Ibid., pp. 22-23.

[25]Ronald W. Colton, "Education and Environment", Proceedings of the International Conference on Human Environment (Kyoto, Japan: November, 1975), p. 35.

[26]Robert Cahn, Footprints on the Planet: A Search for an Environmental Ethic (New York: Universe Books, 1978), pp. 261-268.

[27]Val Arnsdorf, "A Report on the Nature and Status of Environmental Education, "Current Issues in Environmental Education - 1975: Selected papers from the Fourth Annual Conference of The National Association for Environmental Edu-

cation, April 27-29, 1975, ed. Robert Marlett. (Columbus, Ohio: ERIC Center for Science, Mathematics and Environmental Education, The Ohio State University), p. 63.

[28]William B. Stapp, "Historical Setting of Environmental Education," Environmental Education Strategies Toward A More Liveable Future, ed. James A. Swan and William B. Stapp (New York: John Wiley and Sons, 1974), p. 49.

[29]The U.S. Office of Education, A New Role for American Education, (1970), quoted in Val Arnsdorf, "A Report on the Nature and Status of Environmental Education", Current Issues in Environmental Education - 1975. ed. Robert Marlett, p. 63.

[30]Arnsdorf, "A Report on the Nature and Status of Environmental Education", p. 63.

[31]Mary F. Berry and George E. Lowe, "The Challenge of Environmental Education," EPA Journal, Vol. IV, April, 1978. p. 36.

BIBLIOGRAPHY

Aldrich, James L., and Kormondy, Edward J., eds. Environmental Education: Academia's Response Washington, D.C., (1972). Available from the American Institute of Biological Science, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

Arnsdorf, Val. "A Report on the Nature and Status of Environmental Education", Current Issues in Environmental Education - 1975. ed., Robert Marlett. Columbus, Ohio. ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University. pp. 63-70.

Berry, Mary F. and Lowe, George E. "The Challenge of Environmental Education". EPA Journal, Vol. IV, No. 4, (April 1978).

Brown, Lester R. The Twenty-Ninth Day: Accommodating Human Needs and Numbers to The Earth's Resources. New York: Norton, 1978.

Cahn, Robert. Footprints on the Planet: A Search for an Environmental Ethic. New York: Universe Books, 1978.

Carson, Rachel. Silent Spring. Boston: Houghton Mifflin, 1962; rev. ed., New York: Fawcett, 1973.

Cherniak, Stacie and Steinhart, John. The Universities and Environmental Quality Commitment to Problem Focused Education, A Report

to the President's Environmental Quality Council: Office of Science and Technology. Executive Office of the President, September 1969.

Colton, Ronald W. "Education and Environment". Proceedings of the International Conference on Human Environment. Kyoto, Japan: November, 1975.

_____. Mountain View Center for Environment Education, University of Colorado, Boulder, Colorado. Personal Interview, 5 January 1979.

Crowell, John. "Must Helpless Man Roll Darkling?: An Environmental Education Proposal," International Journal of Environmental Studies 4 (1973)

_____. "University Reorganization Through Environmental Studies", Journal of Research and Development in Education 6 (1972): 110-114.

Eggers, Melvin A. "Where Education is Losing Touch", Business Week (September 15, 1975): p. 16.

Ehrilich, Paul R. The Population Bomb. New York: Ballatine, 1968.

Eldridge, Roger. Project Director Education, Thorne Ecological Institute, Boulder, Colorado. Personal Interview, 14 November 1978.

Federal Interagency Committee on Education, U.S. Department of Health, Education and Welfare. Toward an Action Plan: A Report on the Tbilis; Intergovernmental Conference on Environmental Education. A paper developed by the subcommittee on Environmental Education, Walter E. Jeske, Chairman. U.S. Department of Health,

Education and Welfare. Office of the Assistant Secretary for Education. Washington, D.C., March 1978.

Gold, Seymour M. "Environmental Studies: An Educational Prospectus", International Journal of Environmental Studies 3 (1972): 55-64.

Hafner, Everett M. "The Challenge of Environmental Education." BioScience 21 (1971): 535-536.

Herrscher, Walter J., and Cook, Robert S., eds., Environmental Responsibility in Higher Education: Processes and Practices. Green Bay, Wisconsin: 1973. A report of a national conference on environmental studies programs in higher education held at the University of Wisconsin Green Bay, November 30-December 2, 1972. Available from Office of Community Outreach, University of Wisconsin Green Bay, Green Bay, Wisconsin 54302.

Kormondy, Edward J. "Environmental Education: The Whole Man Revisited", American Biology Teacher 33 (1971): 15-17.

McGowan, Alan. "Education: University Programs", Environment, Vol. XV (1973): No. 5: pp. 41-42.

McInnis, Noel and Albrecht, Don, eds., What Makes Education Environmental? Louisville, Kentucky: co-published by Data Courier, Inc. and Environmental Educators, Inc. 1975.

Meadows, Donella H., Meadows, Dennis L., Randers, Jorgen, and Behrens, William W., III. The Limits to Growth. 2nd ed. New York: Universe, 1974.

National Field Research Center. A National Environmental/Energy Workforce Assessment, Phase I (70 volumes). Prepared for the Office of Federal Affairs, U.S. Environmental Protection Agency. Iowa City, Iowa: National Field Research Center, Inc., 1977.

———. A National Environmental/Energy Workforce Assessment, Phase II (13 volumes). Prepared for the Office of Federal Affairs, U.S. Environmental Protection Agency. Iowa City, Iowa: National Field Research Center, Inc., 1978.

Nash, Roderick. "Logs, Universities and the Environmental Education Compromise", Current Issues in Environmental Education - II: Selected Papers from the Fifth Annual Conference of the National Association for Environmental Education. ed. Robert Marlett. Columbus, Ohio: ERIC Center for Science, Mathematics and Environmental Education. The Ohio State University, 1976. pp. 10-20.

———. "Goodbye Renaissance Road", editorial Journal of Environmental Education (Spring 1977): p. 2.

Peterson, Gil. "Integrating a Professional Program in an Interdisciplinary Environmental Studies Program". Journal of Environmental Education, Vo. IX (1978): No. 2: p. 37.

Pollution Engineering: "Pollution Engineering". EPA Annual Report, Vol. VII (December 1975): No. 12. Technical Publishing Company, 1975. pp. 34-35.

Population Division, United Nations Secretariat. Trends and Prospects in Urban and Rural Population, 1950-2000, as Assessed in 1973-74. (Mimeographed.) New York: Ballantine, 1968.

Pratt, Arden, L., ed., Selected Environmental Education Programs in North American Higher Education. National Association for Environmental Education, 1974.

Roberts, John B. Summary of the 3rd National Environmental Engineering Education Conference August 13, 14 and 15, 1973. Sponsored by the American Academy of Environmental Engineers, the Association of Environmental Engineering Professors, and Drexel University: Drexel University, Philadelphia, Pennsylvania, 1973.

Schoenfield, Clarence A. "Environmental Education and the University", Educational Record 49 (1968): 305-310.

———. ed., Outlines of Environmental Education, Madison, Wisconsin. (1971).

Stapp, W.B. "The Concept of Environmental Education". Journal of Environmental Education, Vol. I. (1969): No. 1: pp. 30-31.

———. "Environmental Encounters." Journal of Environmental Education. Vol. II (1970): No. 1: pp. 35-41.

———. "Historical Setting of Environmental Education", Environmental Education Strategies Toward A More Livable Future. ed., James A. Swan and William B. Stapp. New York: John Wiley & Sons, 1974.

Tanner, Thomas R. Ecology, Environment and Education. Lincoln, Nebraska: Professional Educators Publications, Inc., 1974.

The American Institute of Biological Sciences, Environmental Education: The Adult Public, Report of a Workshop Conference. Washington, D.C., (April 6-7, 1970).

The National Association for Environmental Education. Current Issues in Environmental Education - 1975: Selected Papers from the Fourth Annual Conference of the National Association for Environmental Education. April 27-29, 1975. ed. Robert Marlett. Columbus, Ohio: ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University.

The National Association for Environmental Education. Current Issues in Environmental Education - II: Selected Papers from the Fifth Annual Conference of the National Association for Environmental Education. April 25-27, 1976. ed., Robert Marlett. Columbus, Ohio: ERIC Center for Science, Mathematics and Environmental Education. The Ohio State University.